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## HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM (HFACS) MODEL IN ANALYZING CONSTRUCTION ACCIDENTS

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### ABSTRACT

*Industrialization development, which is being implemented in some areas, is increasing rapidly. There are over one hundred thousand construction companies in Indonesia. Thus, the risk of accidents in the construction field is also likely to increase. Moreover, Indonesia is one of the countries with the highest construction accidents according to ASEAN's accident rate. This will cost a significant loss. The Indonesian construction industry should conduct a more in-depth investigation into the problem so that improvements would significantly decrease the accident rate. This research aims to obtain the first modification of HFACS models to be implemented in the companies. Thus, it is expected that there is a correction to the dominant factor. HFACS model is an accident investigation method based on the human error factor. This research is generally divided into three steps. There are preliminary, data collecting, then conclusion and recommendation. Based on the explanation above, it is obtained that the development of the HFACS model is by adding the level of an external factor, which obtained 1,2% in the construction industry. Through the recommendation based on the result of this research, be expected that construction companies in Indonesia could make continuous improvements to reduce the accident.*

### INTRODUCTION

Building workers in the construction sector have a lot of risks in carrying out their work. This is because the construction services industry has a high working intensity, a considerable length of time, the working period of the target, relatively low education as well as many involving abusive labor. On the other hand, the equipment used is also diverse and has a high risk of danger. According to Findley et al. (2004), the construction field industry provides a

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disproportionate amount of work accidents, both fatal and non-fatal. The number of construction accidents in Indonesia is also quite high, which is 31% (Saputra & Herliafifah, 2015). In ASEAN, Indonesia peaked at number five for the highest construction accident based on accident figures (Endroyo & Tugino, 2007). The high number of occupational accidents in the construction service industry indeed resulted in losses from many things. These losses have an impact not only on yourself but also on the company and the environment. To reduce the number of losses incurred, it is necessary to achieve a 'zero accident' in the construction site. The construction did the results of the evaluation and Human Resources Development Agency (2007) which mentioned that several factors are causing the accident, among others: not involved in the construction experts, the lack of the quality and quantity of availability of personal protective equipment (PPE), weak supervision on the implementation of OHS and construction supervision in the field, the use of improper methods, not fully implement The factors causing the accident is significantly related to human.

This study used the HFACS model because this model is still used in several industries. The HFACS model is a structured, modifiable model and not only examines accidents caused by operator accidents but also examines the aftermath of human error, though to find a specific result needed more in-depth study (Lenne et al., 2011). HFACS models have not been the perfect model for investigations, so HFACS models require modifications (Paletz, 2009). According to Hughes & Ferret (2008), the primary influence external to OHS construction is societal. Therefore, the HFACS model's development will be done by adding the most tip layer that is external factors (outside four-layer model HFACS). The examined aspect is the dominant causal factor by implementing the proposed development of HFACS models.

## **RESEARCH METHOD**

### **A. Study of the development of HFACS and Accident report data collection**

This research was conducted using a qualitative model, research, and understanding based on a social phenomenon and human problems. The HFACS model proved to be a good model for identifying accidents (Beaubien & Baker, 2007). The development of the HFACS model in this study was carried out by adding a fifth layer recommended by Yamin (2013), Hughes & Ferret (2008), namely external factors (regulatory and social). External Factors are factors that cause accidents that are outside the scope of a construction company. The external factor is a layer that will be tried to be added in the HFACS Model layer to be applied in the construction of PT X Indonesia. According to Dambier & Hinkelbein (2006), aircraft accident analysis is an important basis for further flight safety in the world of aviation. It can be concluded that accident report data is very important, as well as in the field of construction in Indonesia. The data collected for this study is the final report of a construction accident in the company of the year 2011-2015. The number of reports collected is more than 50 final reports of accidents in the field of construction.

### **B. Data processing**

The final report that has been collected as a whole is then processed using the HFACS model. The stages include: reading the accident report on construction, identifying the causes of the accident, classifying the causes of the accident that have been identified into the taxonomy of the HFACS model and making a summary of the results of the classification. The respondents for this interview were the target users of the HFACS model, namely, practitioners in the safety field (Wang et al., 2011). The questions raised are about the causes and chronology of an accident related to human factors.

### **C. Analysis and Discussion**

Analysis of the HFACS model classification was carried out to determine the percentage of the human factor involved in a crash accident. This percentage is then compared with the company's percentage results and other research on human factors in construction accidents. The next step is to adjust the model for the company PT X. Adjustment here is more on defining and detailing each factor by following under PT X because the guidelines that exist to date are generally for the transportation industry. After making adjustments, classification is carried out

on all data that has been collected. After analyzing the results of the classification of 50 accident reports contained in the company, it can be investigated as the causes of construction work accidents. The dominant factor can also be seen from the results of the analysis that has been done.

#### D. Discussion of Settlement Recommendations and Drawing conclusions

The last discussion is to recommend a solution to minimize recurrence in cases of work accidents. By knowing the influential factors, improvements can be determined the company can apply that. The method of providing recommendations for completion uses references from Hughes and Ferret (2008). The conclusions made must be able to answer the research objectives. The purpose of this study is to get an initial modification of the HFACS model that can be useful to be applied in the construction industry. Making recommendations is intended so that HFACS can be developed even more in Indonesia.

### RESULTS AND DISCUSSION

#### A. Analysis of the Results of the Alleged Development of the HFACS Model

The HFACS Model has not been a perfect model to be used in investigations. Therefore the HFACS Model requires modification (Paletz, 2009). The HFACS model was first developed in the United States, so the observed condition is in the United States and it is different from the conditions in Indonesia. This research proposes to modify the HFACS Model by adding external factors. It has been confirmed by Hughes & Ferret (2008) that one of the causes of construction accidents is the company's external influence. Based on the classification causes of accidents using the HFACS model, 36% are caused by unsafe acts. The second-highest layer causing construction accidents is a precondition for dangerous actions, which is 31.3%. Unsafe supervision also affects 20.1%, and organizational influences 11.4%. As for the fifth layer, external factors are 1.2%.

##### 1. Unsafe Acts

Based on Figure 1, the most dominant factor causing the accident is skill-based, which is included in the category of errors in the unsafe acts layer. As many as 29% of skill-based causes unsafe acts in accidents followed by routines included in the contraventions category with a percentage of 53.1%. Means the root problem of workers who perform unsafe acts are skill-based errors and routine contraventions. Examples of actions included in the routine contravention category found are workers not using PPE (Personal Protective Equipment). Another example of activities that fall into skill-based errors is that the worker does not tidy up or put the equipment in its proper place.

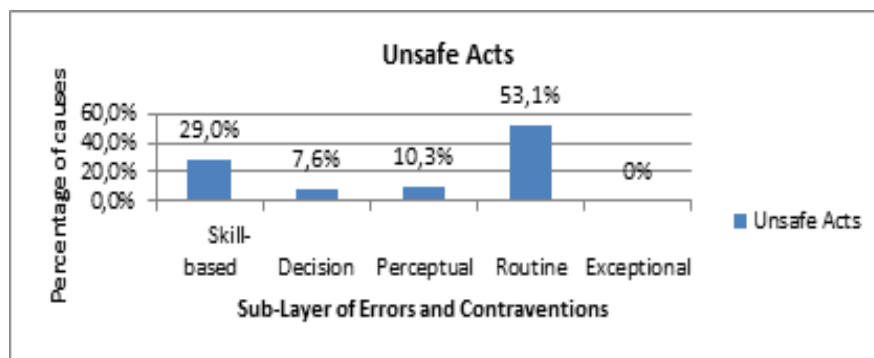


Figure 1. Percentage of Factors that Cause Unsafe Coating Acts

##### 2. The Precondition for Unsafe Acts

Based on Figure 2, the most dominant factor causing the accident was a technological environment of 37.3%, which is included in environmental factors in the precondition for unsafe acts. Also, the physical environment is included in environmental factors with a percentage of

27.8%. Occupational accidents are caused by technological environments such as broken machines, old equipment, or materials that are not suitable for use. This factor's root problem is companies and supervisors who do not care about small things such as the condition of tools/machines. However, if compared to the occurrence of accidents due to the device, the cost of loss can even exceed periodic maintenance costs, even up to many times.

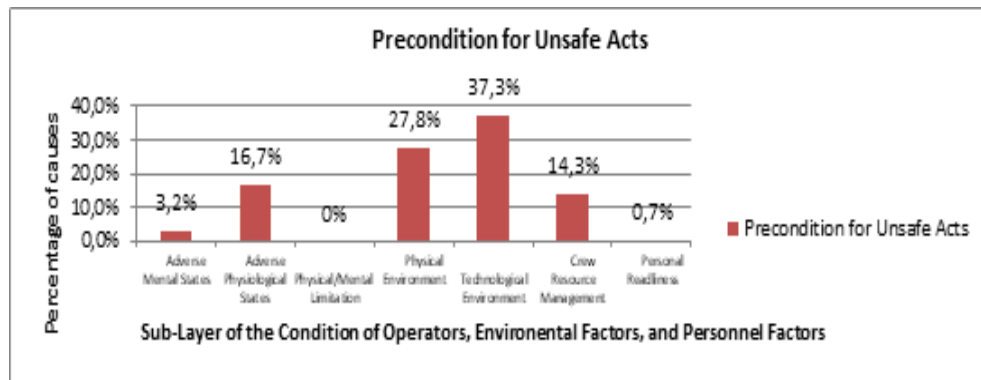


Figure 2. Percentage of Factors that Cause Precondition for Unsafe Acts

### 3. Unsafe Supervision

Based on Figure 3, the unsafe supervision layer's cause occurred in the category of supervision violations by 34.6%. The role of supervisors is very important in minimizing work accidents. The supervisors in this company have done their job well enough. This is because, in this company, SHE (Safety, Health, and Environment) managers often visit projects to control and monitor the project's development and progress from all aspects, including work safety. It is just that the briefing about OHS is done once a week.

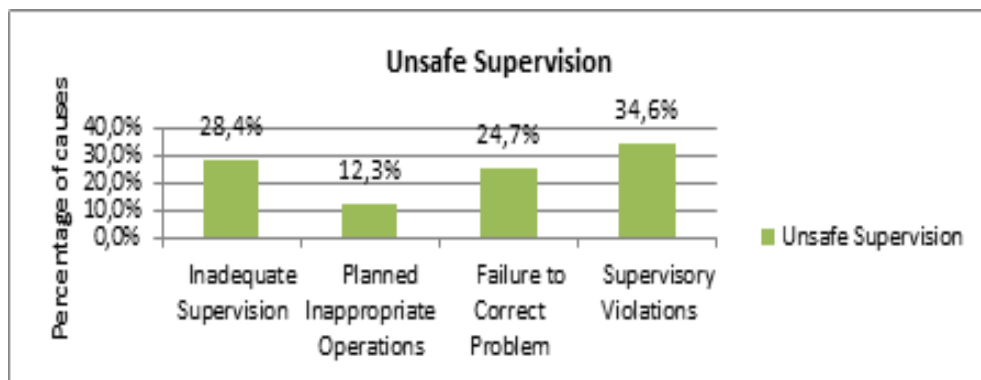


Figure 3. Percentage of Factors that Cause Unsafe Supervision Layer

### 4. Organizational Influences

Based on Figure 4, the organizational process and resource management have the same number in causing accidents. In this company, the influence of the organization is good enough to deal with work accidents. It is proven by the company always coordinating well about accidents between the project head and the SHE manager.

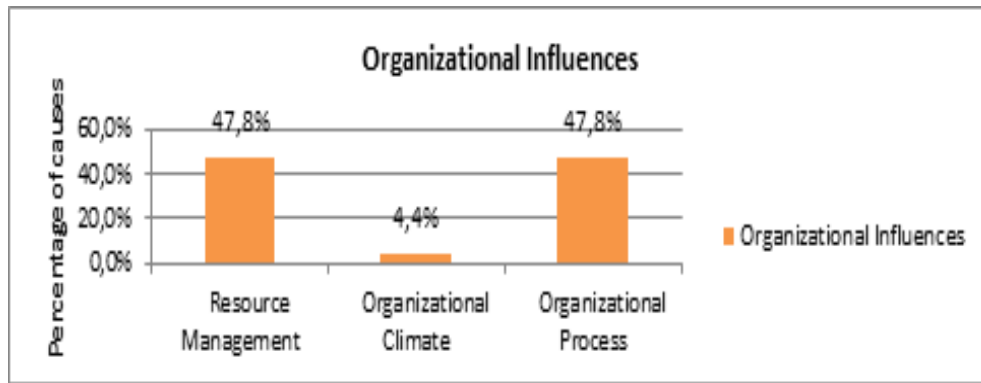


Figure 4. Percentage of Factors that Cause Organizational Layer Influences

## 5. External Factors

In this layer, the factors causing construction accidents to get a percentage of 1.2%. This figure is obtained from 50 accident reports classified according to the existing HFACS model layer. Based on this, it is necessary to anticipate the causes caused from outside the company. Reasons that occur, such as being hit by a car where the driver is sleepy. This should be expected with clearer and stronger project boundaries.

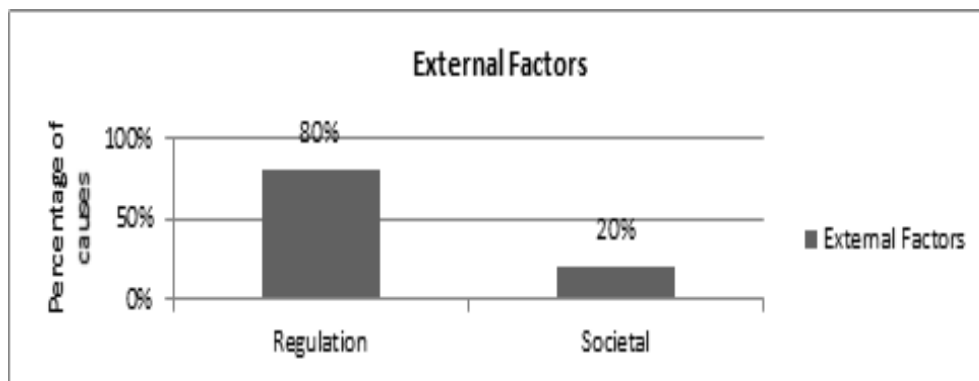


Figure 5. Percentage of Factors Causing External Factors

## B. Development of External Factor Layers in the HFACS Model

The external layers of the factor are regulation and societal. After the criteria are found from the analysis results, then validation is done using case study validation techniques. It is done by paying attention to 4 things: construct validity, internal validity, external validity, and reliability. Additional validation of the development results was carried out through interviews with construction experts and observers in Indonesia. Interviews were conducted with professors in construction management and engineering. Both of these experts were asked to provide views on the results of research and efforts that could be made to reduce the number of construction accidents in Indonesia. From the interview results, one of the professors agreed that indeed indiscipline of most workers was the main cause of accidents. Based on the top manager's area's viewpoint, resource persons A and B said that all causes are related. Occupational health and safety (OHS) will not run smoothly if there is only one person who does not support this program.

## CONCLUSIONS

There is an external factor in the construction industry's context, with a figure of 1.2% of all reported accidents that have been studied and are the early modification of the HFACS model. Recommendations are made to employees, supervisors, and companies to improve the OHS system on each project: (1) Creating such work-related systems: selection based on education and working with APD and training for workers at the start of project work; (2) Briefing the OHS every day before doing the job; (3) Implement a new program such as sticking to a major injury; (4) A supervisor who needs more discipline and who wants to enforce rules; (5) Regulatory enforcement and feedback systems. Improvement efforts are made to address the root of the problem so that no accidents are caused by similar causes and can wish to implement the model HFACS in each accident report to perform more structured and more complete evaluations.

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